US009131365B2

(12) **United States Patent**
Nicholson et al.

(10) **Patent No.: US 9,131,365 B2**
(45) **Date of Patent: Sep. 8, 2015**

(54) **METHODS, APPARATUSES AND COMPUTER PROGRAM PRODUCTS FOR SECURING COMMUNICATIONS**

(71) Applicant: **Syniverse Technologies, LLC**, Tampa, FL (US)

(72) Inventors: **Christopher Nicholson**, Seffner, FL (US); **Kenneth W. Hammer**, Lutz, FL (US)

(73) Assignee: **SYNIVERSE TECHNOLOGIES, LLC**, Tampa, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 424 days.

(21) Appl. No.: **13/747,018**

(22) Filed: **Jan. 22, 2013**

(65) **Prior Publication Data**

US 2014/0162619 A1 Jun. 12, 2014

Related U.S. Application Data

(60) Provisional application No. 61/736,338, filed on Dec. 12, 2012.

(51) **Int. Cl.**
H04W 8/24 (2009.01)

(52) **U.S. Cl.**
CPC ***H04W 8/245*** (2013.01)

(58) **Field of Classification Search**
CPC ... H04W 84/005; H04W 4/046; H04W 16/18; H04W 4/04; H04W 4/027
USPC 455/445, 422.1; 713/153–154, 168–171
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,174,018	B1 *	2/2007	Patil et al.	380/258
2006/0059265	A1 *	3/2006	Keronen	709/228
2007/0206571	A1 *	9/2007	Silver	370/352
2008/0056235	A1 *	3/2008	Albina et al.	370/352
2011/0151836	A1 *	6/2011	Dadu et al.	455/411
2012/0115491	A1 *	5/2012	Nicholson et al.	455/445
2013/0308470	A1 *	11/2013	Bevan et al.	370/252
2014/0051422	A1 *	2/2014	Mittal et al.	455/419

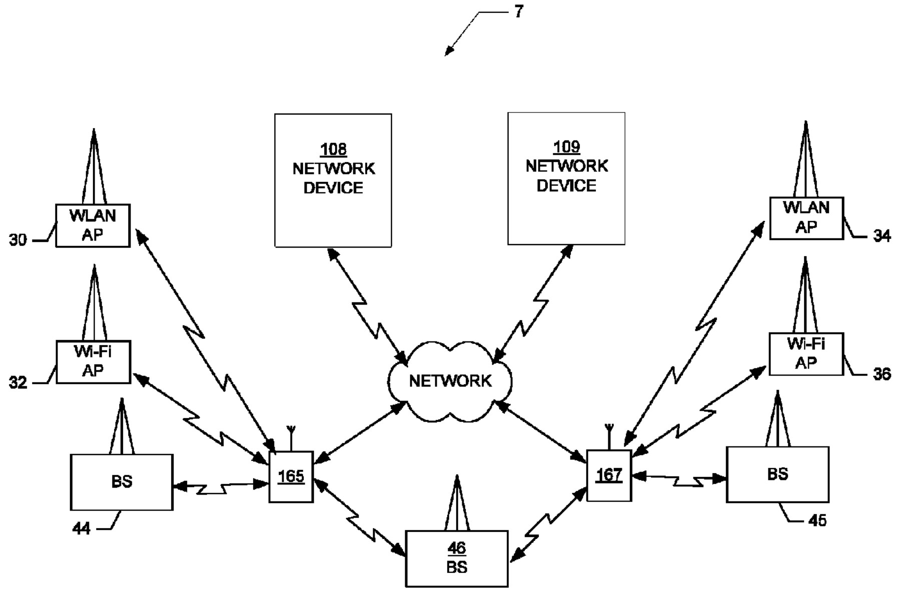
* cited by examiner

Primary Examiner — Amir Mehrmanesh
(74) *Attorney, Agent, or Firm* — Alston Bird LLP

(57) **ABSTRACT**

An apparatus for securing communications includes a processor and memory storing executable computer code causing the apparatus to at least perform operations including receiving a request to activate a service transferring communications of a cellular network to a wireless local network. The computer program code may further cause the apparatus to provide an activation key to a device responsive to an indication that the device is authorized to utilize the service based on determining an identifier(s) of the request is valid. The computer program code may further cause the apparatus to provide a private key to the device, to enable the device to utilize the private key to subsequently register to transfer communications of the cellular network to a wireless local network(s), responsive to receiving a message for the private key from the device and a message from the cellular network. Corresponding methods and computer program products are also provided.

21 Claims, 8 Drawing Sheets



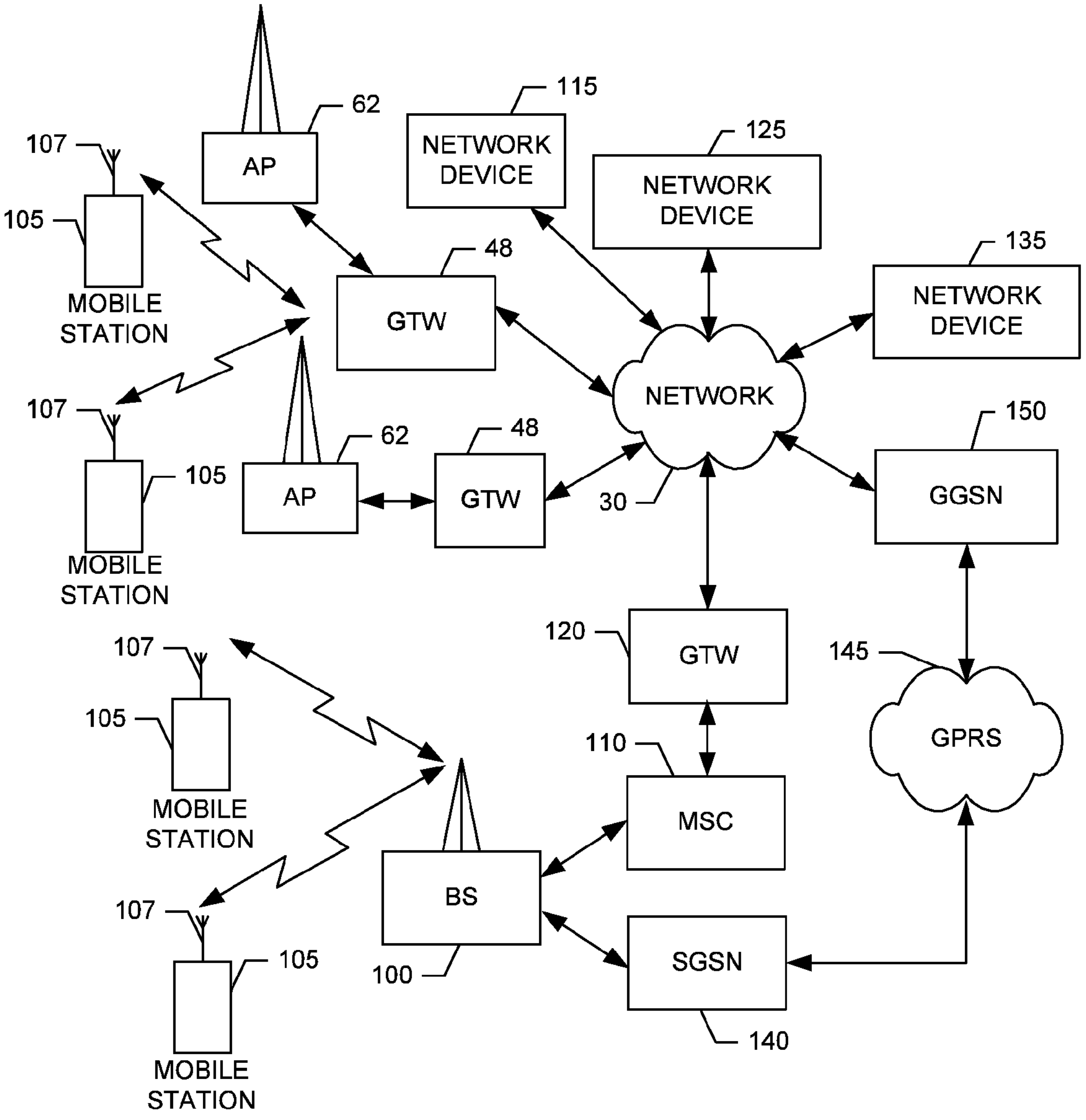

62
AP
107
105
MOBILE STATION
115
NETWORK DEVICE
125
NETWORK DEVICE
48
GTW
135
NETWORK DEVICE
NETWORK
107
62
48
AP
GTW
30
105
MOBILE STATION
150
GGSN
107
120
GTW
145
105
MOBILE STATION
110
MSC
GPRS
107
BS
105
100
SGSN
140
MOBILE STATION

FIG. 1.

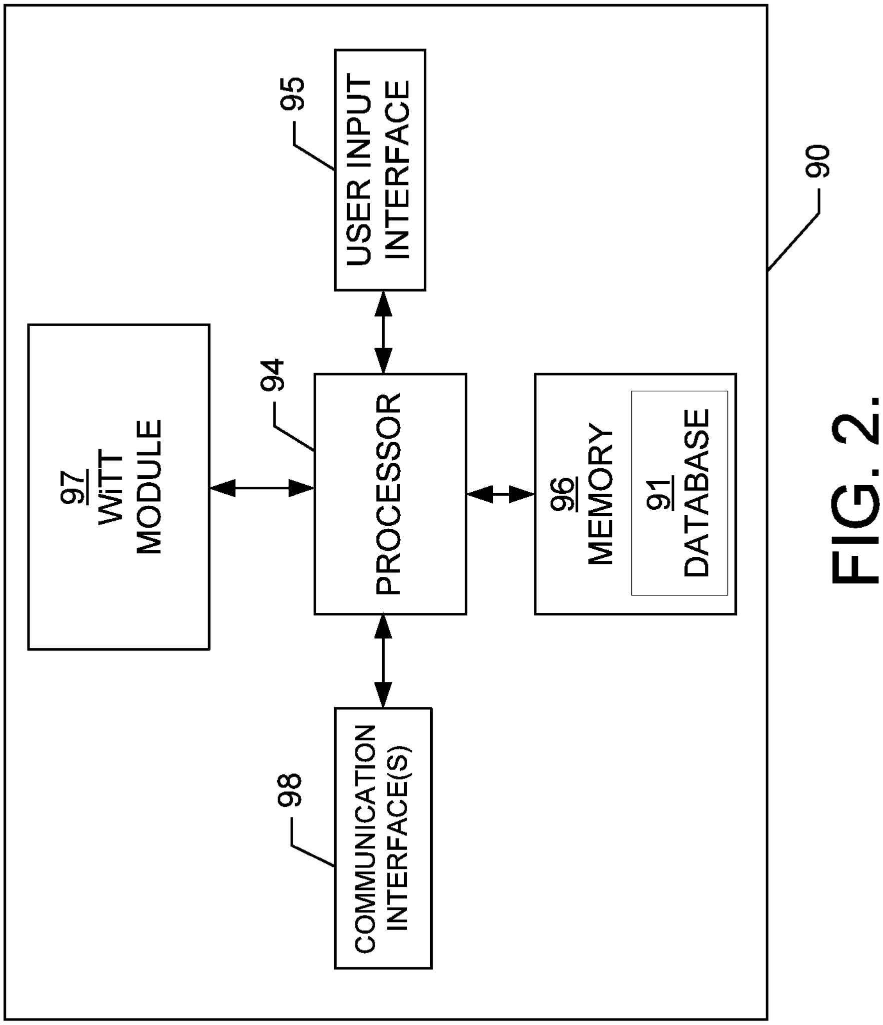

95
USER INPUT INTERFACE
90
97
WiTT MODULE
94
PROCESSOR
96
MEMORY
91
DATABASE
98
COMMUNICATION INTERFACE(S)

FIG. 2.

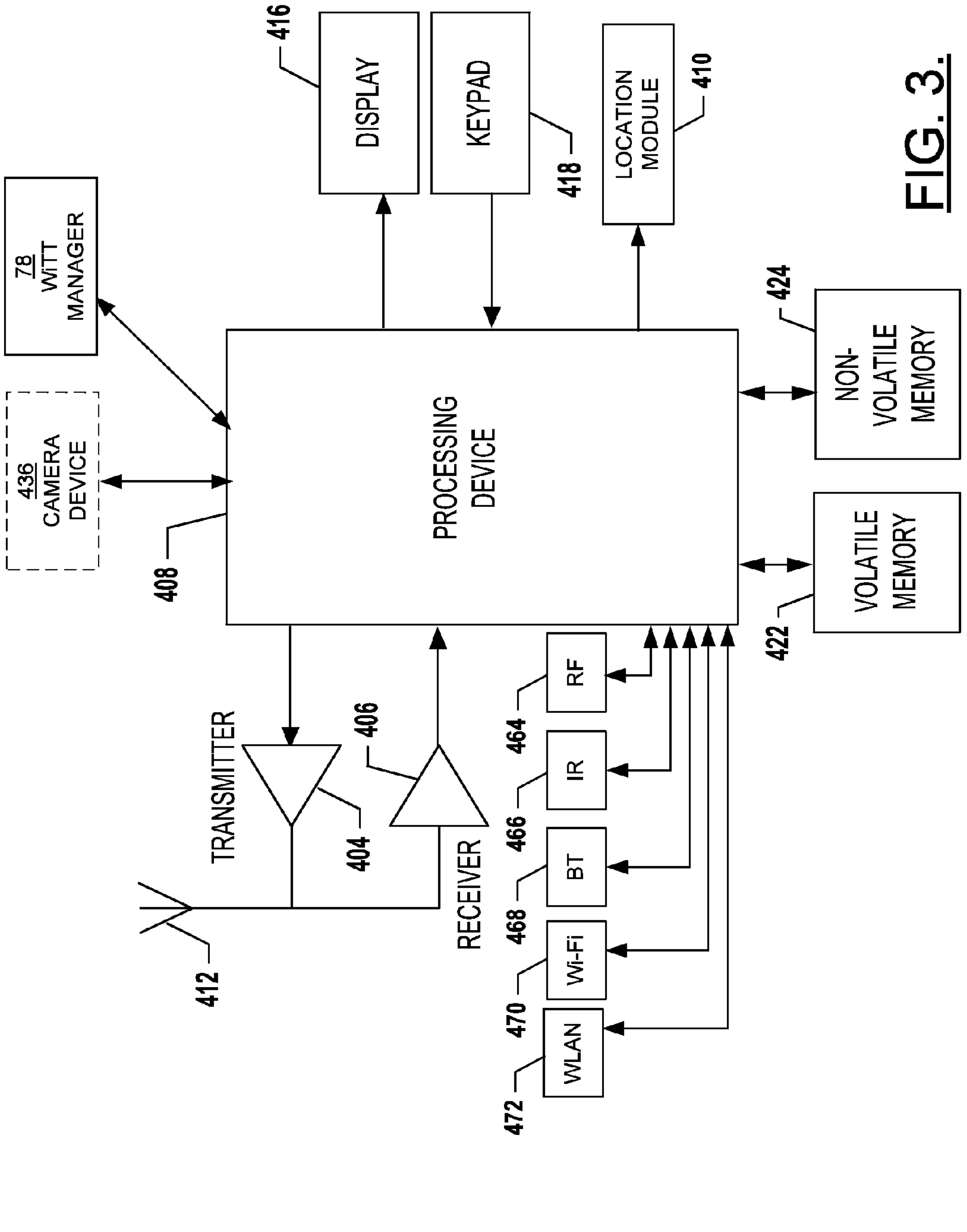

105
436
CAMERA
DEVICE
78
WITT
MANAGER
408
PROCESSING
DEVICE
416
DISPLAY
KEYPAD
418
LOCATION
MODULE
410
424
NON-
VOLATILE
MEMORY
VOLATILE
MEMORY
422
412
TRANSMITTER
404
406
RECEIVER
RF
464
IR
466
BT
468
Wi-Fi
470
WLAN
472

FIG. 3.

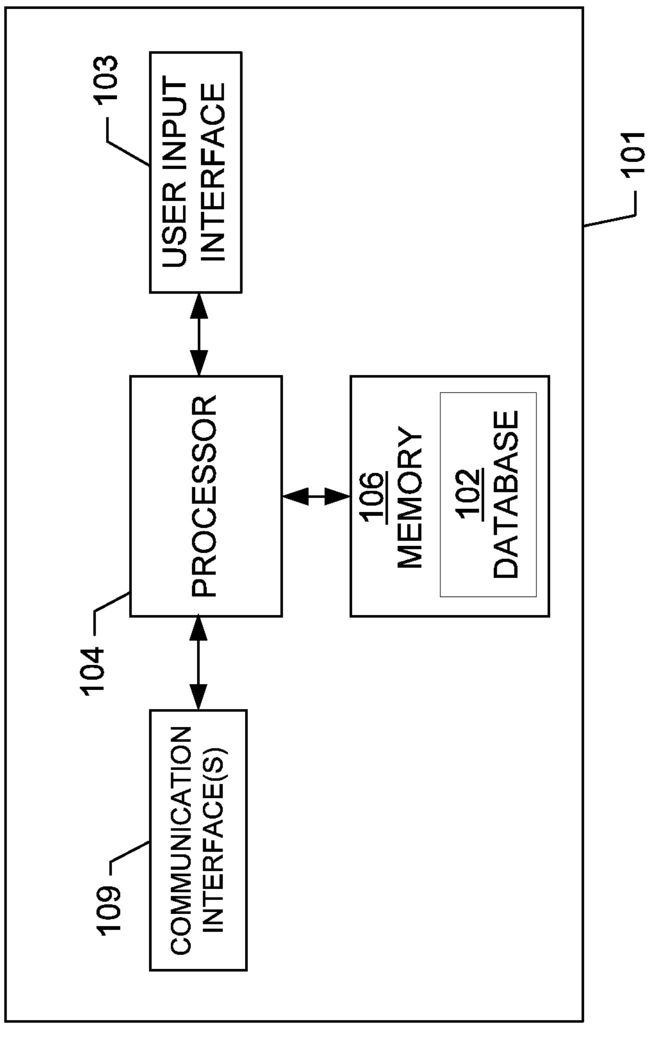

103
USER INPUT INTERFACE
101
PROCESSOR
104
106 MEMORY
102 DATABASE
109
COMMUNICATION INTERFACE(S)

FIG. 4.

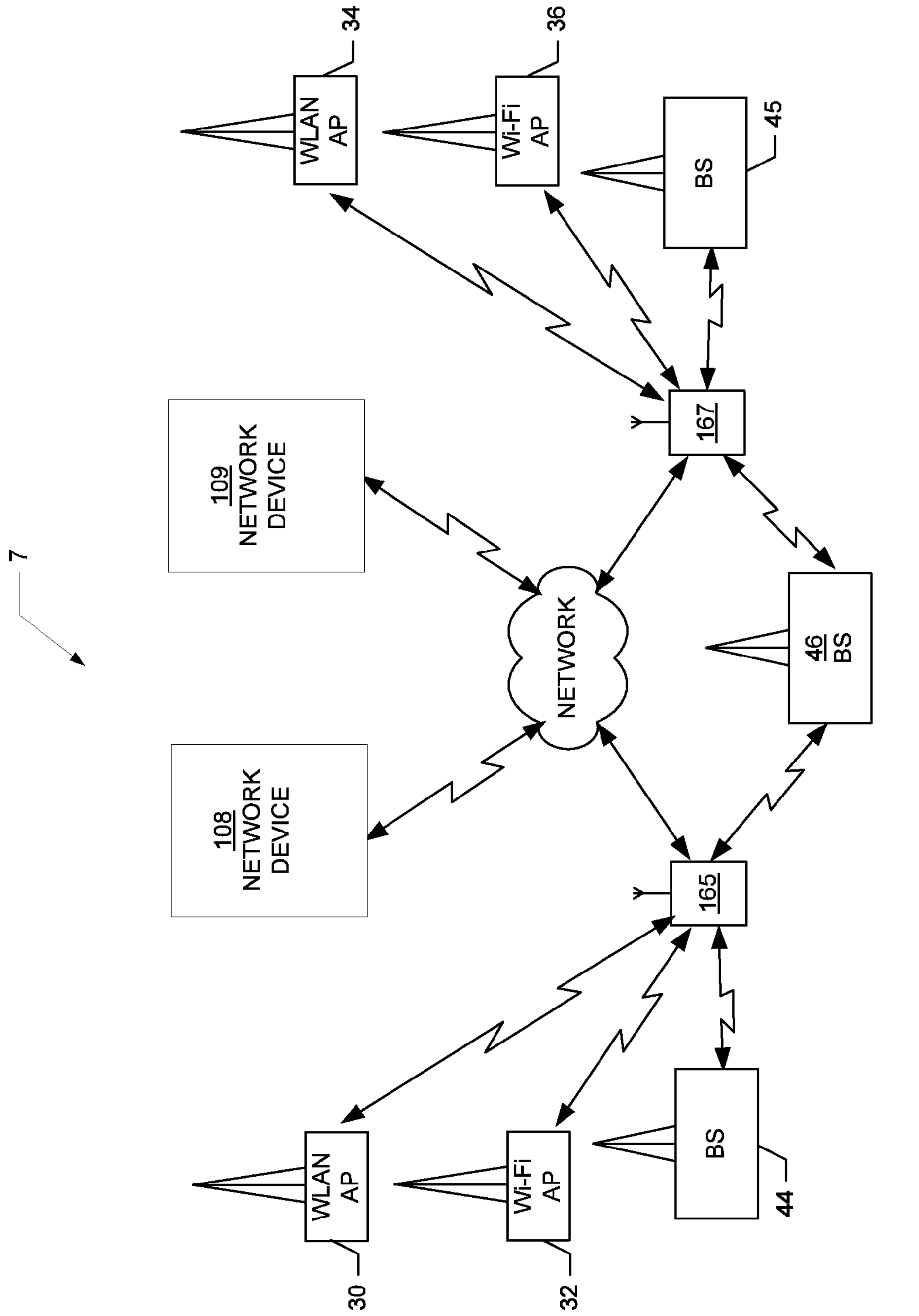

7
34
WLAN AP
36
Wi-Fi AP
45
BS
109 NETWORK DEVICE
167
NETWORK
46 BS
108 NETWORK DEVICE
165
WLAN AP
Wi-Fi AP
BS
44
30
32

FIG. 5.

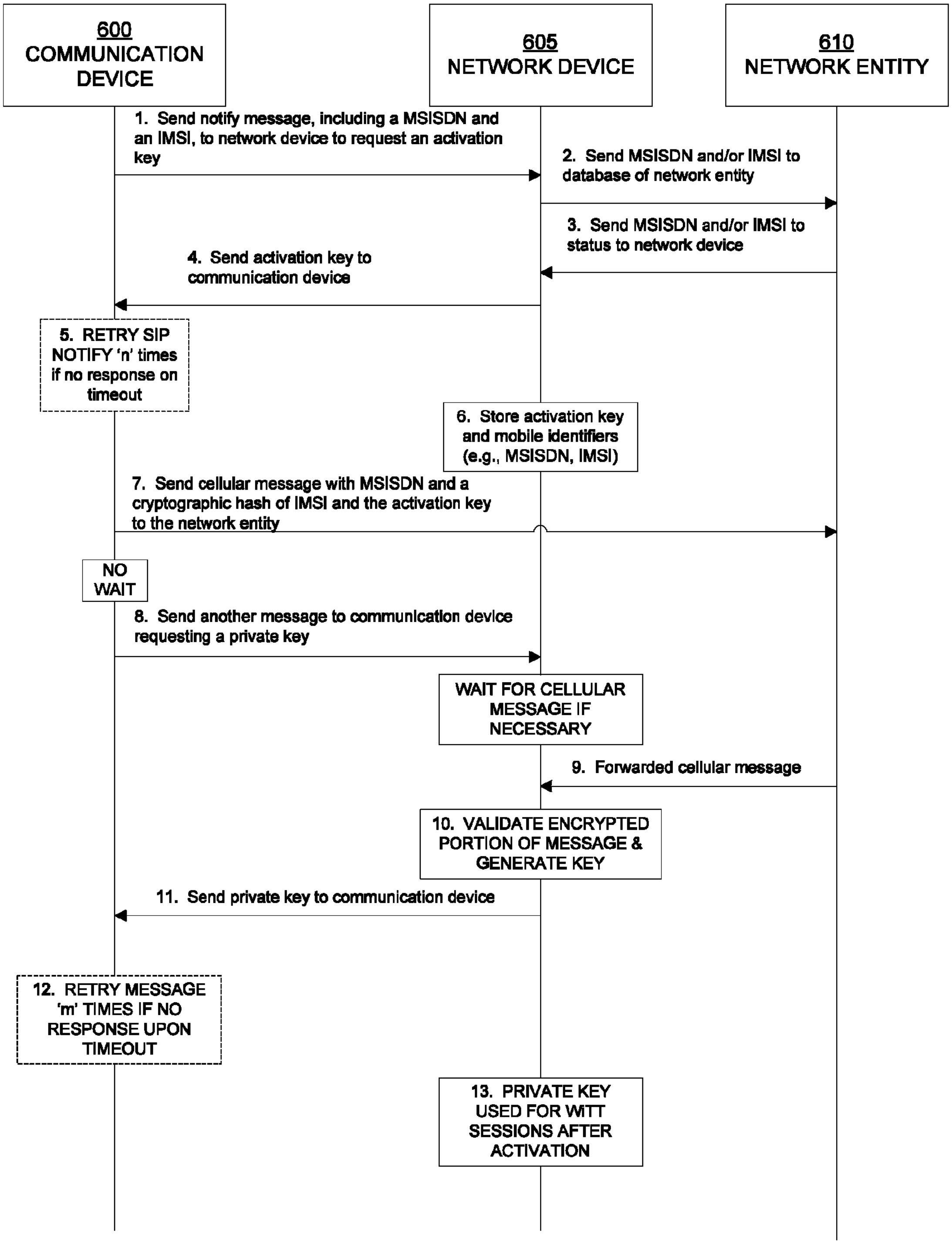

600
COMMUNICATION DEVICE
605
NETWORK DEVICE
610
NETWORK ENTITY
1. Send notify message, including a MSISDN and an IMSI, to network device to request an activation key
2. Send MSISDN and/or IMSI to database of network entity
3. Send MSISDN and/or IMSI to status to network device
4. Send activation key to communication device
5. RETRY SIP NOTIFY 'n' times if no response on timeout
6. Store activation key and mobile identifiers (e.g., MSISDN, IMSI)
7. Send cellular message with MSISDN and a cryptographic hash of IMSI and the activation key to the network entity
NO WAIT
8. Send another message to communication device requesting a private key
WAIT FOR CELLULAR MESSAGE IF NECESSARY
9. Forwarded cellular message
10. VALIDATE ENCRYPTED PORTION OF MESSAGE & GENERATE KEY
11. Send private key to communication device
12. RETRY MESSAGE 'm' TIMES IF NO RESPONSE UPON TIMEOUT
13. PRIVATE KEY USED FOR WITT SESSIONS AFTER ACTIVATION

FIG. 6.

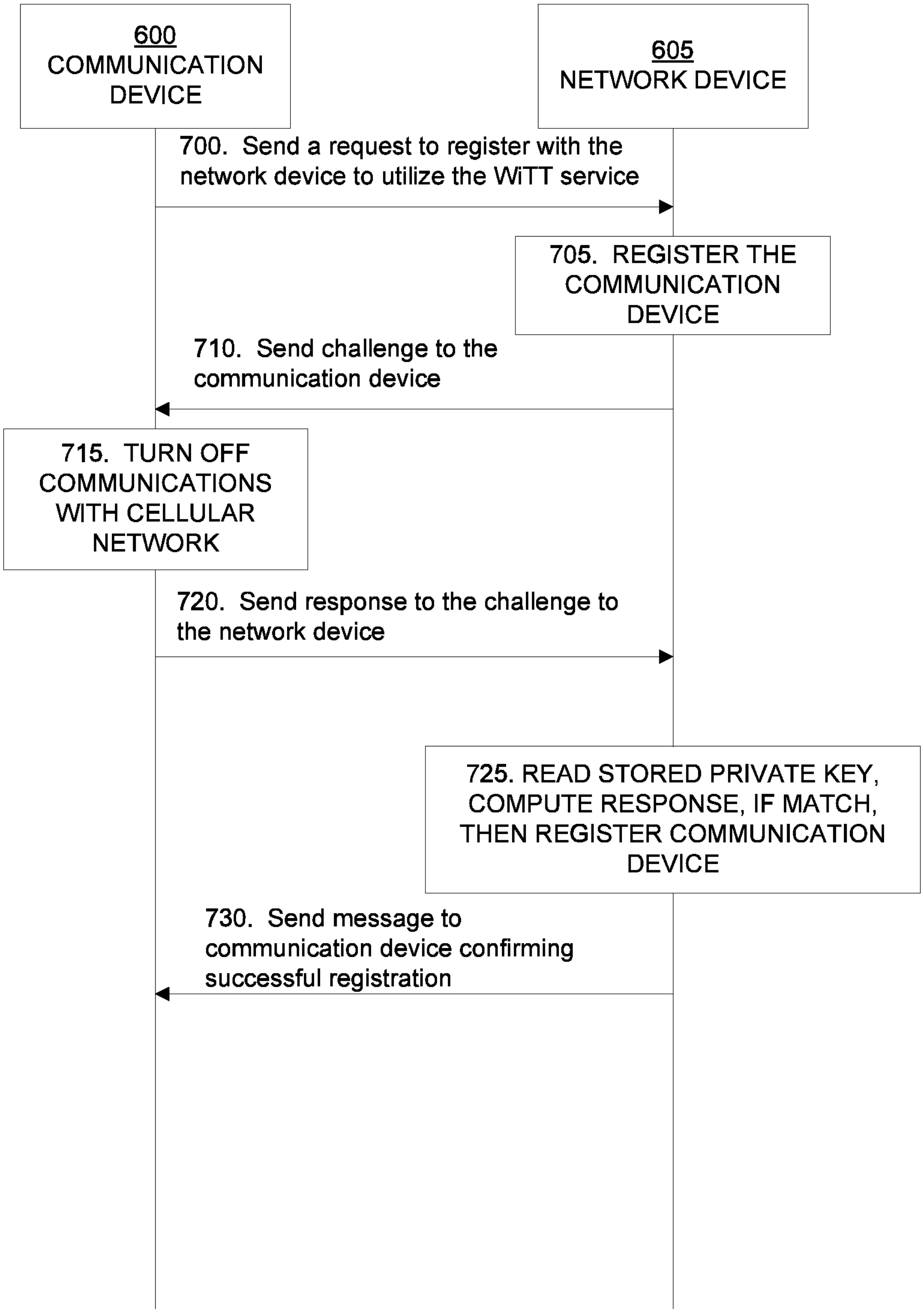

600
COMMUNICATION DEVICE
605
NETWORK DEVICE
700. Send a request to register with the network device to utilize the WiTT service
705. REGISTER THE COMMUNICATION DEVICE
710. Send challenge to the communication device
715. TURN OFF COMMUNICATIONS WITH CELLULAR NETWORK
720. Send response to the challenge to the network device
725. READ STORED PRIVATE KEY, COMPUTE RESPONSE, IF MATCH, THEN REGISTER COMMUNICATION DEVICE
730. Send message to communication device confirming successful registration

FIG. 7.

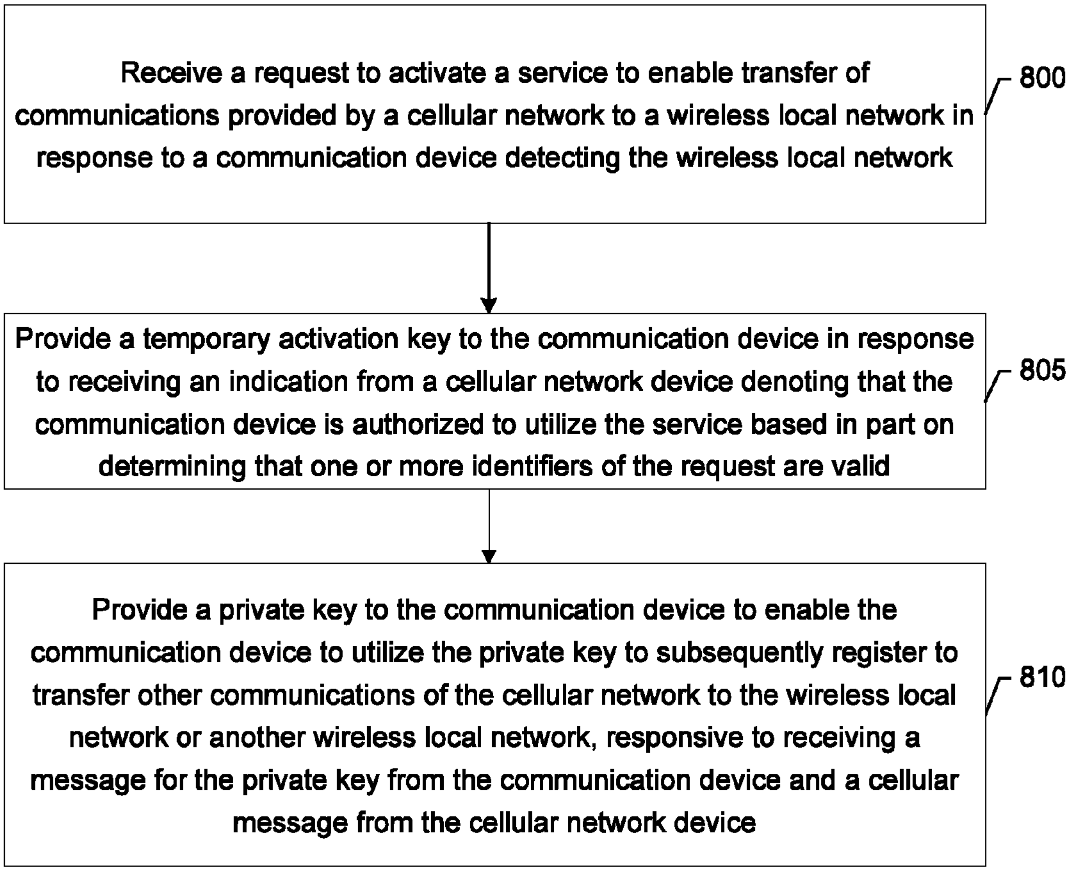

Receive a request to activate a service to enable transfer of communications provided by a cellular network to a wireless local network in response to a communication device detecting the wireless local network
800
Provide a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid
805
Provide a private key to the communication device to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network to the wireless local network or another wireless local network, responsive to receiving a message for the private key from the communication device and a cellular message from the cellular network device
810

FIG. 8.

METHODS, APPARATUSES AND COMPUTER PROGRAM PRODUCTS FOR SECURING COMMUNICATIONS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims benefit of U.S. Provisional Application No. 61/736,338 filed Dec. 12, 2012, the contents of which are hereby incorporated herein in their entirety by reference.

TECHNOLOGICAL FIELD

Embodiments of the invention relate generally to wireless communication technology and, more particularly relate to an apparatus, method and a computer program product for facilitating secure authorization of transfer of communications from a cellular system to a local network in communications systems.

BACKGROUND

Currently, demand for high-quality mobile voice and messaging capabilities regardless of location continues to grow. However, given the ubiquitous nature of communication devices, many mobile operators may have coverage gaps in areas of their network. For example, there may be gaps in coverage areas in buildings, or basements of homes or the like to name a few. Additionally, many mobile operators may desire to expand their coverage areas for providing communication services to users. However, expanding coverage areas may be costly.

As such, it may be beneficial to provide a mechanism for increasing coverage areas of network operators to accommodate consumer demand and alleviate network bandwidth strains while minimizing costs.

BRIEF SUMMARY

A method, apparatus and computer program product are therefore provided for enabling provision of voice and messaging over a wireless local network(s) that extends coverage into wireless local network areas in a secure manner. An example embodiment may reduce roaming costs for network operators and their subscribers, and may facilitate more efficient usage of a mobile network.

As such, an example embodiment may enable a communication device to utilize a network as normal when the communication device is not within range of the wireless local network (e.g., a wireless local area network (WLAN), a Wireless. Fidelity (Wi-Fi) network). The communication device may automatically switch to a Voice over Internet Protocol (VoIP) (e.g., a Session Initiation Protocol (SIP)) such as, for example, SIP-based calling and messaging in an instance in which the communication device enters a proximity of the wireless local network.

An example embodiment may facilitate authorization of a service to enable the transfer of communications from a cellular network to a wireless local network (e.g., a Wi-Fi access point). For instance, authorization or authentication may be achieved by an example embodiment in an instance in which a cellular operator(s) authenticates a communication device (s) (e.g., mobile station(s)) by sending an encrypted message to a network device (e.g., a WiTT network device). In this regard, the network device of an example embodiment may send a challenge (e.g., a random challenge (e.g., a random

number)) to the communication device (e.g., a mobile station) and the communication device may perform a calculation using a secret key (e.g., a private key) and may return a response to the network device. In an instance in which the network device determines that the response is an expected value the network device may authenticate the communication device. In response to authenticating the communication device, the communication device may transfer communications from the cellular network to a detected wireless local network (e.g., a Wi-Fi access point, a WLAN access point, etc.).

In one example embodiment, a method for securing communications is provided. The method may include receiving a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network. The method may further include enabling provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid. The method may further include enabling provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device. The cellular message was initially received by the cellular network device from the communication device.

In another example embodiment, an apparatus for securing communications is provided. The apparatus may include a processor and memory including computer program code. The memory and the computer program code are configured to, with the processor, cause the apparatus to at least perform operations including receiving a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network. The memory and computer program code are also configured to, with the processor, cause the apparatus to enable provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid. The memory and computer program code are also configured to, with the processor, cause the apparatus to enable provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device. The cellular message was initially received by the cellular network device from the communication device.

In another example embodiment, a computer program product for securing communications is provided. The computer program product includes at least one computer-readable storage medium having computer-executable program code portions stored therein. The computer-executable program code instructions may include program code instructions configured to cause receipt of a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network. The program code instructions may also be configured to enable provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid. The program code instructions may also be configured to enable provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device. The cellular message was initially received by the cellular network device from the communication device.

An embodiment of the invention may provide a better user experience since communication device users may utilize voice and messaging over wireless local networks in addition to cellular networks by facilitating reliable coverage in areas where wireless local networks are available in a secure manner.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a schematic block diagram of a system according to an example embodiment of the invention;

FIG. **2** is a schematic block diagram of a network device according to an example embodiment of the invention;

FIG. **3** is a schematic block diagram of a mobile station according to an example embodiment of the invention;

FIG. **4** is a schematic block diagram of a network device according to another example embodiment of the invention; and

FIG. **5** is schematic block diagram of a system according to an example embodiment of the invention;

FIG. **6** is a diagram of a signal flow according to an example embodiment of the invention;

FIG. **7** is a diagram of a signal flow according to another example embodiment of the invention; and

FIG. **8** is a flowchart illustrating operations performed in accordance with one example embodiment of the invention.

DETAILED DESCRIPTION

Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Like reference numerals refer to like elements throughout. As used herein, the terms "data," "content," "information" and similar terms may be used interchangeably to refer to data capable of being transmitted, received and/or stored in accordance with embodiments of the invention. Moreover, the term "exemplary", as used herein, is not provided to convey any qualitative assessment, but instead merely to convey an illustration of an example. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the invention.

As defined herein, a "computer-readable storage medium," which refers to a non-transitory, physical or tangible storage

medium (e.g., volatile or non-volatile memory device), may be differentiated from a "computer-readable transmission medium," which refers to an electromagnetic signal.

I. Exemplary System Architecture

Referring now to FIG. **1**, an illustration of a communication system that can be used in conjunction with various example embodiments of the invention is provided. The system includes a plurality of network devices. As shown, one or more mobile stations **105** may each include an antenna **107** for transmitting signals to and for receiving signals from a base site or base station (BS) **100**. The base station **100** may be a part of one or more cellular or mobile networks each of which includes elements required to operate the network, such as a mobile switching center (MSC) **110**. In operation, the MSC **110** is capable of routing calls to and from the mobile stations **105** when the mobile stations **105** are making and receiving calls. The MSC **110** may also provide a connection to landline trunks when a mobile station(s) **105** is involved in a call. In addition, the MSC **110** is configured to control the forwarding of messages to and from the mobile stations **105**, and can also control the forwarding of messages for the mobile stations **105** to and from a messaging center.

The MSC **110** may be coupled to a data network, such as a local area network (LAN), a metropolitan area network (MAN), and/or a wide area network (WAN). The MSC **110** can be directly coupled to the data network. In one example embodiment, however, the MSC **110** may be coupled to a gateway (GTW) **120**, and the GTW **120** is coupled to a WAN, such as the network **30** (e.g., the Internet). In turn, devices such as processing elements (e.g., personal computers, server computers or the like) can be coupled to the mobile stations **105** via the network **30** (e.g., the Internet). For example, as explained below, the processing elements can include one or more processing elements associated with a network device **115**, a network device **125** and a network device **130**.

The BS **100** may also be coupled to a Serving General Packet Radio Service (GPRS) Support Node (SGSN) **140**. The SGSN **140** is capable of performing functions similar to the MSC **110** for packet switched services. The SGSN **140**, like the MSC **110**, can be coupled to a data network **30**, such as, for example, the Internet, or private network (e.g., a GPRS roaming exchange (GRX), an Internetwork Packet Exchange (IPX), a CDMA (Code Division Multiple Access) Packet Data Roaming Exchange (CRX), etc.). The network **30** may be used between mobile operators for data roaming as well as for any other suitable communications. The SGSN **140** can be directly coupled to the data network. In an example embodiment, however, the SGSN **140** is coupled to a packet-switched core network, such as a GPRS core network **145** (also referred to herein as GPRS system **145**). The packet-switched core network is then coupled to another gateway, such as a GTW GPRS support node (GGSN) **150**, and the GGSN **150** is coupled to the network **30** (e.g., the Internet). In addition to the GGSN **150**, the packet-switched core network may also be coupled to a GTW **120**.

In addition, by coupling the SGSN **140** to the GPRS core network **145** and the GGSN **150**, devices such as a network device **115** (e.g., a server (e.g., a WiTT server), network device **125** (e.g., a server (e.g., a server of an operator such as, for example, a cellular operator), and/or network device **135** may be coupled to the mobile stations **105** via the network **30**. In this regard, devices such as the network device **115**, the network device **125**, and/or network device **135** may communicate with each other and/or with the mobile stations **105** across the SGSN **140**, GPRS core network **145**, the GGSN

150 and the network **30**. By directly or indirectly connecting mobile stations **105** and the other devices (e.g., network device **115**, network device **125**, network device **135**, etc.) to the network **30**, the mobile stations **105** may communicate with the other devices and with one another, such as according to the Hypertext Transfer Protocol (HTTP), to thereby carry out various functions of the mobile stations **105**.

The mobile stations **105** may further be coupled to one or more wireless access points (APs) **62**. The APs **62** may comprise access points configured to communicate with the mobile terminal **10** in accordance with techniques such as, for example, radio frequency (RF), Bluetooth (BT), infrared (IrDA) or any of a number of different wireless networking techniques, including, Wireless Fidelity (Wi-Fi), wireless LAN (WLAN) techniques such as IEEE 802.11 (e.g., 802.11a, 802.11b, 802.11g, 802.11n, etc.), WiMAX techniques such as IEEE 802.16, and/or ultra wideband (UWB) techniques such as IEEE 802.15 or the like. The APs **62** may be coupled to the network **30**. Like with the MSC **110**, the APs **62** can be directly coupled to the network **30**. In one embodiment, however, the APs **62** are indirectly coupled to the network **30** via a GTW **48**.

II. Exemplary Witt Network Device

Referring now to FIG. **2**, a block diagram of one example of a network device (e.g., a server) is provided. As shown in FIG. **2**, the network device **90** (also referred to herein as a Wi-Fi Talk & Text (WiTT) network device **90**) (e.g., network device **115**) generally includes a processor **94** and an associated memory **96**. The memory **96** may comprise volatile and/or non-volatile memory, and may store content, data and/or the like. For example, the memory may store content, data, information, and/or the like transmitted from, and/or received by, the network device. Also for example, the memory **96** may store client applications, instructions, and/or the like for the processor **94** to perform the various operations of the network device **90** in accordance with an embodiment of the invention, as described herein. The memory **96** may include a database **91** that stores indications of detected access points (APs) (e.g., Wi-Fi APs, WLAN APs, etc.) as well as other data (e.g., Mobile Station Integrated Services Digital Networks (MSISDNs), international mobile subscriber identities (IMSIs), etc.).

Additionally, as such, whether configured by hardware or software methods, or by a combination thereof, the processor **94** may comprise an entity capable of performing operations according to embodiments of the present invention while configured accordingly. Thus, for example, when the processor **94** is embodied as an ASIC, FPGA or the like, the processor **94** may comprise specifically configured hardware for conducting one or more operations described herein. Alternatively, as another example, when the processor **94** is embodied as an executor of instructions, such as may be stored in the memory **96**, the instructions may specifically configure the processor **94** to perform one or more algorithms and operations described herein.

In addition to the memory **96**, the processor **94** may also be connected to at least one interface or other means for displaying, transmitting and/or receiving data, content, and/or the like. In this regard, the interface(s) may comprise at least one communication interface **98** or other means for transmitting and/or receiving data, content, and/or the like, as well as at least one user input interface **95**. The user input interface **95**, in turn, may comprise any of a number of devices allowing the WiTT network device **90** to receive data from a user, such as a keypad, a touch display, a joystick, a microphone and a speaker or other input device. In this regard, the processor **94** may comprise user interface circuitry configured to control at least some functions of one or more elements of the user input interface. The processor and/or user interface circuitry of the processor may be configured to control one or more functions of one or more elements of the user interface through computer program instructions (e.g., software and/or firmware) stored on a memory accessible to the processor (e.g., volatile memory, non-volatile memory, and/or the like).

In an example embodiment, the processor **94** may be embodied as, include or otherwise control the WiTT module **97**. The WiTT module **97** may be any means such as a device or circuitry operating in accordance with software or otherwise embodied in hardware or a combination of hardware and software (e.g., processor **94** operating under software control, the processor **94** embodied as an ASIC or FPGA specifically configured to perform the operations described herein, or a combination thereof) thereby configuring the device or circuitry to perform the corresponding functions of the WiTT module **97**, as described below. Thus, in an example in which software is employed, a device or circuitry (e.g., the processor **94** in one example) executing the software forms the structure associated with such means.

III. Exemplary Mobile Station

FIG. **3** provides an illustrative schematic representative of a mobile station **105** that may be used in conjunction with the example embodiments of the invention. As shown in FIG. **3**, the mobile station **105** (also referred to herein as MS **105**) may include an antenna **412**, a transmitter **404**, a receiver **406**, and a processing device **408** (e.g., a processor, controller, and/or the like) that provides signals to and receives signals from the transmitter **404** and receiver **406**, respectively.

The signals provided to and received from the transmitter **404** and the receiver **406**, respectively, may include signaling information in accordance with an air interface standard of applicable wireless systems. In this regard, the mobile station **105** may be capable of operating with one or more air interface standards, communication protocols, modulation types, and access types. More particularly, the mobile station **105** may operate in accordance with any of a number of second-generation ("2G") communication protocols, third-generation ("3G") communication protocols, fourth-generation ("4G"), Global System for Mobile Communications ("GSM"), Universal Mobile Telecommunications System ("UMTS"), Long Term Evolution ("LTE"), LTE-Advanced ("LTE-A") GPRS, W-CDMA, CDMA communication protocols, and/or the like. Further, for example, the mobile station **105** may operate in accordance with any of a number of different wireless networking techniques, including Bluetooth, Wireless Local Area Network (WLAN), IEEE 802.11 ("Wi-Fi"), 802.16 ("WiMAX"), ultra wideband ("UWB"), and/or the like. Via these communication standards and protocols, the mobile station **105** may communicate with various other entities using concepts such as Unstructured Supplementary Service Data ("USSD"), Short Message Service ("SMS"), Dual-Tone Multi-Frequency Signaling ("DTMF"), and/or Subscriber Identity Module Dialer ("SIM dialer"). The mobile station **105** can also download changes, add-ons, and updates, for instance, to its firmware, software (e.g., including modules), and operating system.

The mobile station **105** may also comprise an optional user interface (that can include a display **416** coupled to a processing device **408**) and/or a user input interface (coupled to the processing device **408**). The user input interface can comprise any of a number of devices allowing the mobile station **105** to receive data, such as a keypad **418**, a touch display, voice or motion interfaces, or other input device. In embodiments including a keypad **418**, the keypad **418** can include the conventional numeric (0-9) and related keys (#, *), and other keys used for operating the mobile station **105** and may include a full set of alphabetic keys or set of keys that may be activated to provide a full set of alphanumeric keys. In addition to providing input, the user input interface can be used, for example, to activate or deactivate certain functions, such as screen savers and/or sleep modes.

The mobile station **105** may further include a location module **410** in communication with the processing device **408**. The location module **410** may be any device or means for locating the position of the mobile station **105**. The location module **410** may include all hardware for locating the position of a mobile station **105**. Alternatively or additionally, the location module **410** may utilize a memory (e.g., volatile memory **422**, non-volatile memory **424**) of the mobile station **105** to store instructions for execution by the processing device **408** in the form of software necessary to determine the position or location of the mobile station **105**. Additionally, the location module **410** is capable of utilizing the processing device **408** to transmit/receive, via the transmitter **404**/receiver **406**, locational information (e.g., one or more geolocation codes (e.g., an identifier indicating a geographic location of an object (e.g., mobile station **105**)) such as the position of the mobile station **105**, to a network device (e.g., a server), such as, for example, the network devices **115**, **125**, **135**.

The mobile station **105** may also include a Near Field Communications (NFC) transceiver (also referred to herein as short range radio frequency (RF) transceiver) and/or interrogator **464** so data may be shared with and/or obtained from electronic devices (e.g., a RF access point(s)) in accordance with RF techniques. The mobile station **105** may also include other transceivers such as, for example, an infrared (IR) transceiver **466**, a Bluetooth (BT) transceiver **468** operating using Bluetooth brand wireless technology developed by the Bluetooth Special Interest Group, and/or the like. Additionally, the mobile station **105** may include a Wi-Fi transceiver **470** configured to transmit and/or receive data from electronic devices (e.g., a Wi-Fi access point(s)) according to a Wireless Fidelity (Wi-Fi) technique. The mobile station **105** may also include a WLAN transceiver **472** configured to transmit and/or receive data from electronic devices (e.g., a WLAN access point(s)) according to various wireless networking techniques, including WLAN techniques such as IEEE 802.11 techniques, and/or the like. In this regard, the mobile station **105** and, in particular, the Near Field Communications transceiver may be capable of transmitting data to and/or receiving data from electronic devices (e.g., a tag (e.g., a Radio-Frequency Identification (RFID) tag), an IR access point(s), a BT access point(s), a Wi-Fi AP, a WLAN AP, etc.) within a proximity of the mobile station **105**, such as within 10 meters, for example.

The mobile station **105** may also include an optional camera device **436**. The camera device **436** may include a camera, video and/or audio module, in communication with the processing device **408** and the display **416**. The camera device **436** may be any means for capturing an image, video and/or audio for storage, display or transmission. For example, the camera device **436** may include a digital camera configured to form a digital image file from a captured image. As such, the camera device **36** may include all hardware, such as a lens or other optical component(s), and software necessary for creating a digital image file from a captured image. In an alternative example embodiment, the camera device **436** may include only the hardware needed to view an image, while a memory device (e.g., volatile memory **422** and/or non-volatile memory **424**) of the mobile station **105** stores instructions for execution by the processing device **408** in the form of software necessary to create a digital image file from a captured image.

In some cases, the camera device **436** may provide live image data to the display **416**. In this manner, the camera device **436** may facilitate or provide a camera view to the display **416** to show live image data, still image data, video data, or any other data.

The mobile station **105** may also include volatile memory **422** and/or non-volatile memory **424**, which can be embedded and/or may be removable. For example, the non-volatile memory may be embedded or removable MMCs, secure digital SD memory cards, Memory Sticks, EEPROM, flash memory, hard disk, or the like. The memory can store any of a number of pieces or amount of information and data used by the mobile station **105** to implement the functions of the mobile station **105**. The memory (e.g., volatile memory **422**, non-volatile memory **424**) may be an electronic storage device (e.g., a computer readable storage medium) comprising gates configured to store data (e.g., bits) that may be retrievable by a machine (e.g., a computing device like processing device **408**). In an example embodiment, the memory may be a tangible memory that is not transitory. The memory may be configured to store instructions (e.g., software instructions, computer program code instructions) for execution by the processing device **408**. In this regard, for example, the memory may store content, such as computer program code for an application and/or other computer programs.

In an example embodiment, the processing device **408** may be embodied as, include or otherwise control the WiTT manager **78**. The WiTT manager **78** may be any means such as a device or circuitry operating in accordance with software or otherwise embodied in hardware or a combination of hardware and software (e.g., processing device **408** operating under software control, the processing device **408** embodied as an ASIC or FPGA specifically configured to perform the operations described herein, or a combination thereof) thereby configuring the device or circuitry to perform the corresponding functions of the processing device **408**, as described below. Thus, in an example in which software is employed, a device or circuitry (e.g., the processing device **408** in one example) executing the software forms the structure associated with such means.

IV. Exemplary Network Device

Referring now to FIG. **4**, a block diagram of an example embodiment of a network device is provided. In an example embodiment, the network device **101** (e.g., network device **125**). As shown in FIG. **4**, the network device (e.g., a server) generally includes a processor **104** and an associated memory **106**. The memory **106** may comprise volatile and/or non-volatile memory, and may store content, data and/or the like. The memory **106** may store client or server applications, instructions, and/or the like for the processor **104** to perform the various operations of the network device **101**. In an example embodiment, the memory **106** may include a database **102** that stores MSISDNs, IMSIs of corresponding communication devices and any other suitable data. The database **102** may store data indicating whether users/subscribers of communication devices are authorized to utilize a WiTT service.

The processor **104** may also be connected to at least one communication interface **109** or other means for displaying, transmitting and/or receiving data, content, and/or the like. The user input interface **103** may comprise any of a number of devices allowing the network device **101** to receive data from a user, such as a keypad, a touch display, a joystick or other input device. In this regard, the processor **104** may comprise user interface circuitry configured to control at least some functions of one or more elements of the user input interface. The processor **104** and/or user interface circuitry of the processor may be configured to control one or more functions of one or more elements of the user interface through computer program instructions (e.g., software and/or firmware) stored on a memory accessible to the processor (e.g., volatile memory, non-volatile memory, and/or the like).

V. Exemplary System

Referring now to FIG. **5**, an example embodiment of a system according to an example embodiment is provided. The system **7** may include one or more access points (APs) such as, for example, a WLAN AP **30**, a Wi-Fi AP **32**, a WLAN AP **34** and a Wi-Fi AP **36**. The system **7** may also include one or more cellular towers, such as, for example, base stations (BSs) **44**, **45**, **46**. Additionally, the system **7** may include one or more communication devices **165** and **167** (e.g., e.g., mobile station **105**) as well as network device **108** (e.g., network device **90**) and network device **109** (e.g., network device **101**).

In the example embodiment of FIG. **5**, the network device **108** (e.g., also referred to herein as WiTT network device **108**) may be dedicated to switching a communication device (e.g., communication device **165**, communication device **167**) from cellular communications to IP-based (e.g., SIP-based) communications (e.g., calling and/or messaging) in response to receiving an indication from a communication device(s) indicating that the communication device(s) is within a proximity of an access point(s) (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-Fi AP **36**). In this regard, a communication device may utilize a detected access point(s) (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-Fi AP **36**) to facilitate a call and/or other communication(s) (e.g., a message(s)). As referred to herein, communications by one or more communication devices (e.g., communication device **165**, communication device **167**) via an access point(s) (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-Fi AP **36**) may be referred to herein as WiTT communications. The WiTT communications may be managed and provisioned as a WiTT service by the WiTT network device **108**. In an example embodiment, the network device **108** may communicate with an operator of network device **109** to determine whether a user or subscriber of a communication device(s) (e.g., communication device **165**, communication device **167**) is authorized to activate and utilize the WiTT service, as described more fully below. The network device **109** (also referred to herein as cellular network device **109**) may provide cellular communications to one or more communication devices (e.g., communication device **165**, communication device **167**) via a cellular service.

Although FIG. **5** shows one WLAN AP **30**, one Wi-Fi AP **32**, one WLAN AP **34**, one WLAN AP **36**, three cellular towers (e.g., BS's **44**, **45**, **46**), two communication devices **165**, **167**, and two network devices **108**, **109**, it should be pointed out that any suitable number of WLAN APs **30**, Wi-Fi APs **32**, WLAN APs **34**, Wi-Fi APs **36**, cellular towers (e.g., BS's), communication devices **165**, **167** and network devices **108**, **109** may be part of the system **7** without departing from the spirit and scope of the invention.

VI. Exemplary Operation

In the example embodiment of FIG. **5**, the WiTT network device **108** may transfer cellular service provided to a communication device(s) (e.g., communication device **165**, communication device **167**) from the network device (e.g., network device **109**) providing cellular communication services to one or more wireless access points (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-Fi AP **36**) providing IP-based (e.g., SIP-based) communications.

In an instance in which the WiTT manager **78** of a communication device (e.g. communication device **165**, communication device **167**) detects a signal from a wireless local network(s) such as, for example, an access point(s) (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-FI AP **36**), the WiTT manager **78** may send a message to the WiTT network device **108**. The message sent to the WiTT network device **108** may indicate a request by the WiTT manager **78** to transfer communications by using the WiTT service. In this regard, the WiTT network device **108** may verify or authenticate that the user of the communication device is authorized to utilize the WiTT service. In response to determining that the user is authorized to utilize the WiTT service, the WiTT network device **108** may turn off or deactivate the cellular services of the communication device (e.g., communication device **165**) and may enable the communication device (e.g., communication device **165**) to utilize a detected wireless local network(s) (e.g., WLAN AP **30**, Wi-Fi AP **32**, WLAN AP **34**, Wi-Fi AP **36**) for communications such as, for example, IP-based (e.g., SIP-based) communications corresponding to voice calls, messaging (e.g., data messages (e.g., Short Message Service (SMS) messages, Multimedia Messaging Service (MMS) messages)) and/or other communication data. In this regard, a WiTT module **97** of the network device **108** may switch calls and/or messaging (e.g., SMS messages, MMS messages, etc.) from a network (e.g., network device **109**) that provides cellular service to a wireless local network, detected by the communication device (e.g., communication device **165**), providing IP-based communications.

For purposes of illustration and not of limitation, consider an example in which the WiTT manager **78** of a communication device (e.g., communication device **165**) detects a Wi-Fi signal (e.g., a beacon) from a Wi-Fi access point (e.g., Wi-Fi AP **32**) at a coffee shop. In this regard, in an instance in which the WiTT manager **78** determines that it has not previously detected this Wi-Fi access point at the coffee shop, the WiTT manager **78** may provide an indication or notification (e.g., via visible indicia provided to a display (e.g., display **416**)) to a user of the communication device requesting the user to verify whether the user wants the WiTT service to be active for this Wi-Fi access point. In response to the receipt of an indication of the network device **108** from the WiTT manager **78** that the user selected the WiTT service to be active on the Wi-Fi access point of the coffee shop, the WiTT module **97** may store an indication of the Wi-Fi access point in a database (e.g., database **91**) of a memory (e.g., memory **96**). As such, in an instance in which the WiTT manager **78** detects this Wi-Fi access point of the coffee shop in the future, WiTT module **97** may transfer a cellular communication(s) (e.g., a call (e.g., a voice call), a data message (e.g., a SMS message, a MMS message) provided via a cellular network (e.g., network device **109**) of the communication device onto the WiTT service while the user is at the coffee shop. In this manner, the communication device may utilize the Wi-Fi access point of the coffee shop for communications (e.g., IP communications (e.g., a VoIP call, a SMS message, a MMS message)) transferred from the cellular network.

In an example embodiment, the WiTT module **97** of the network device **108** may not necessarily transfer an active call (e.g., a voice call) in real time in all instances. For instance, referring back to the coffee shop example, in an instance in which the user enters the coffee shop and is in an active call via the communication device (e.g., communication device **165**), the WiTT module **97** may leave the call on the cellular network (e.g., network device **109**) until the call is ended in order to minimize the impact of interrupting the call and dropping the call. Thereafter, the WiTT module **97** may activate the WiTT service such that subsequent communications with the Wi-Fi access point of the coffee shop are facilitated via the Wi-Fi access point. On the other hand, the WiTT module **97** may activate the WiTT service in real time for messaging (e.g., SMS messages, MMS messages) and other data communications (e.g., email messages, etc.). As such, the WiTT manager **78** may utilize the detected Wi-Fi access point of the coffee shop, for example, in real time when communicating messaging and other data communications.

In an example embodiment, activation of the WiTT service may be securely accomplished by the WiTT network device **108** communicating with a communication device (e.g., communication device **165**, communication device **167**). For example, the first instance in which the WiTT manager **78** is activated or executed, the WiTT manager **78** may communicate with the WiTT module **97** of the network device **108** to utilize the WiTT service. In this regard, the WiTT module **97** of the network device **108** may communicate with the WiTT manager of the communication device to attempt to establish security credentials for the first time. As such, the WiTT module **97** of the network device **108** may leverage an existing cellular service provided by a network (e.g., network device **109**) to determine whether the user of the communication device is authorized to utilize the WiTT service.

For instance, the WiTT module **97** of the network device **108** may perform a process to attempt to establish a SIP communication(s) and a SMS message over a cellular network (e.g., network device **109**) simultaneously or concurrently to authenticate that the WiTT manager **97** running or being executed on a communication device is authorized to utilize the cellular network (e.g., cellular network **109**) and the WiTT service based in part on a particular identity (e.g., a MSISDN, a IMSI, etc.), as described more fully below.

Referring now to FIG. **6**, a diagram illustrating a signal flow according to an example embodiment is provided. In response to the WiTT manager **78** detecting a wireless local network (e.g., Wi-Fi AP **32**), the WiTT manager **78** may wake up and determine that it does not have the credentials to access the WiTT service. As such, the WiTT manager **78** may send a notify message (e.g., a SIP NOTIFY message) to WiTT module **97** of the network device and may request an activation key (e.g., a temporary activation key). As such, at operation **1**, a communication device **600** (e.g., communication device **165**, communication device **167**) may initiate authentication by establishing a secure channel and sending a message (e.g., a SIP NOTIFY) message to the network device **605** (also referred to herein as WiTT network device **605**) (e.g., network device **108**) requesting an activation key. An MSISDN (e.g., a phone number) and/or an IMSI (International Mobile Subscription Identity) may be included in the message by a WiTT manager (e.g., WiTT manager **78**) of the communication device **600**.

At operation **2**, the WiTT network device **605** may send the MSISDN and/or the IMSI in a query/message to a database (e.g., database **102**) of a cellular network (e.g., network entity **610** (e.g., network device **109**)) to ensure that the identities (e.g., the MSISDN and/or the IMSI) provided are valid and that the user of the communication device **600** is authorized to utilize the WiTT service. In one example embodiment, the query sent to the network entity **610** (also referred to herein as cellular network entity **610**) may be sent according to a Lightweight Directory Address Protocol (LDAP). In another example embodiment, the query may be sent to a Home Location Register (HLR) of the network entity **610** via Signaling System No. 7 (SS7) or the like. At operation **3**, a processor (e.g., processor **104**) of the network entity **610** may analyze the database and may return status information to the network device **605** indicating whether the MSISDN and/or IMSI are valid (e.g., associated with a current subscription). In an instance in which the WiTT module (e.g., WiTT module **97**) of the network device **605** determines that the MSISDN and/or the IMSI are invalid (e.g., not associated with a current subscription), the WiTT module **97** may terminate the activation by the WiTT manager **78** to utilize the WiTT service.

At operation **4**, in an instance in which the WiTT module **97** of the network device **605** determines that the MSISDN and/or IMSI are valid, the WiTT module **97** may provide an activation key (e.g., an encrypted activation key (e.g., a temporary activation key)) to the communication device **600**. The activation key may be provided by the WiTT module **97** to the communication device **600** in a message (e.g., a 200 OK message including an activation key). Optionally, at operation **5**, in an instance in which the communication device **600** does not receive the activation key within a timeout period, the communication device **600** may retry sending of the message (e.g., a SIP NOTIFY message) requesting the activation key 'n' times and may then declare a failure to activate the user on the WiTT service in an instance in which the activation key is not received in the timeout period. In an example embodiment, the network device **605** may also send a message (e.g., a SIP message) rejecting an invalid MSISDN and/or IMSI.

At operation **6**, the WiTT module **97** of the network device **605** may store the activation key and the mobile identifiers (e.g., the MSISDN, IMSI, etc.). At operation **7**, the communication device may generate a cellular message (e.g., a cellular SMS message) containing a MSISDN of the communication device and an encrypted form of the IMSI and activation key (e.g., a cryptographic hash). The communication device may send the generated cellular message (e.g., cellular SMS message) to a cellular network (e.g., network entity **610**) providing cellular service to the communication device **600**.

At operation **8**, without waiting for any response from the network entity **610** regarding the cellular message (e.g., cellular SMS message), the communication device **600** may send a second message (e.g., a SIP NOTIFY message), to the network device **605** requesting a private key. At operation **9**, the WiTT network device **605** may receive the second message (e.g., a SIP NOTIFY message) and a forwarded cellular message (e.g., cellular SMS message) from the cellular network (e.g., network entity **610**) in any order. In this example, the cellular message (e.g., cellular SMS message) forwarded from the cellular network (e.g., network entity **610**) may take longer to arrive. However, the WiTT network device **605** may, for example, simultaneously or concurrently receive both the message requesting the private key from the communication device **600** and the forwarded SMS message from the cellular network (e.g., network entity **610**). The forwarded cellular message (e.g., cellular SMS message) received from the cellular network (e.g., network entity **610**) may indicate that the user of the communication device **600** is authorized to utilize the cellular network (e.g., cellular network entity **610**) based in part on a processor (e.g., processor **104**) of the cellular network analyzing the mobile identities (e.g., MSISDN, IMSI, etc.) of communication device **600** and confirming that the user is authorized to use the cellular network. The forwarded cellular message (e.g., cellular SMS message) received from the network entity **610** may be sent via SS7 SMS message.

At operation **10**, when the forwarded cellular message (e.g., cellular SMS message) and the SIP NOTIFY are both received by the WiTT network device **605**, the encrypted portion (e.g., a cryptographic hash) of the cellular message (e.g., cellular SMS message) may be validated by the WiTT module **97** using the stored MSISDN, the activation key and the IMSI. In an instance in which only the second message (e.g., a SIP NOTIFY message) requesting the private key is received, the WiTT network device **605** may send an error message to the communication device **600**. In an instance in which only the cellular message (e.g., cellular SMS message) is received by the WiTT network device **605** during a timeout period, the cellular message (e.g., cellular SMS message) may be discarded by the WiTT network device **605**.

At operation **11**, in an instance in which the WiTT module **97** of the network device **605** determines that the forwarded cellular message (e.g., cellular SMS message) and the message (e.g., a SIP NOTIFY message) requesting the private key are valid, the WiTT module **97** of the WiTT network device **605** may send the private key to the communication device. In an example embodiment, the WiTT network device **605** may send the private key (also referred to herein as WiTT private key (WPK)) to the communication device in an encrypted message (e.g., a SIP 200 OK message). In this regard, the communication device **600** may extract the WiTT private key and store it for later use. For example, in the future when the communication device **600** attempts to register to utilize the WiTT service, the WiTT module **97** may send the communication device **600** a challenge (e.g., a random challenge) to prove that the communication device **600** was assigned the private key to utilize the WiTT service and switch communications from the cellular network (e.g., cellular network entity **610**) to a detected wireless local network, as described more fully below.

Optionally, at operation **12**, in an instance in which the communication device **600** does not receive a response (e.g., a SIP response) for the requested private key within a timeout period the communication device **600** may retry transmission of both the message (e.g., SIP NOTIFY message) requesting the private key and the cellular message (e.g., cellular SMS message) up to 'm' times during a timeout period.

At operation **13**, the private key may also be stored by the WiTT network device **605** for use on each future transaction by the user/subscriber of the communication device **605**. For example, in an instance in which the communication device **600** detects a wireless local network (e.g., a Wi-Fi AP) in a subsequent instance and desires to switch communications to the detected wireless local network, the WiTT module **97** of the WiTT network device **605** may utilize the stored private key to authorize the communication device to utilize the WiTT service to transfer the communications to the wireless local network. In addition, the activation key may be temporary and may be deleted, by the WiTT network device **605**, at this time, along with associated information.

Referring now to FIG. **7**, a signal flow diagram according to another example embodiment is provided. In the example embodiment of FIG. **7**, the communication device has previously received the WiTT private key from the WiTT module **97** of the network device and as such is previously activated to utilize the WiTT service. In response to the communication device **600** subsequently detecting a wireless local network (e.g., Wi-Fi AP **32**), the user of the communication device **605** may desire to transfer communication services from a cellular network to the detected wireless local network. In this regard, at operation **700**, the communication device **600** may send a request to the network device **605** to register (e.g., a SIP register) with the network device to utilize the WiTT service. The request to register (e.g., a SIP register) sent to the network device **605** may be a request to transfer or switch communication services from the cellular network to a detected wireless local network (e.g., Wi-Fi AP **32**). The request may include data indicating an MSISDN (e.g., phone number) and/or an IMSI of the communication device **600**. The WiTT module **97** of the network device **605** may analyze the MSISDN and/or IMSI received in the request and compare this data to a corresponding MSISDN and/or IMSI stored in memory (e.g., memory **96**) and may determine that the communication device **600** was previously authorized to utilize the WiTT service. As such, at operation **705**, the WiTT module **97** of network device **605** may register the communication device **600** to utilize the WiTT service to transfer communications to a detected wireless local network.

At operation **710**, the WiTT module **97** of the network device **605** may send a challenge (e.g., a random challenge (e.g., a random challenge per Request for Comments (RFC) 2617)) to the communication device **600**. The sent challenge may include a random value. At operation **715**, in response to receiving the challenge from the network device **605**, the communication device **600** may turn off communications with a cellular network (e.g., network entity **615**). At operation **720**, the WiTT manager **78** of the communication device may send a response (e.g., a SIP register response) to the challenge to the network device **605**. The communication device may determine a response value by running a hash on the WiTT private key previously received from the network device **605**. The response value may be included in the response sent to the network device. At operation **725**, the WiTT module **97** of the network device **605** may read or analyze a stored private key assigned to a user of the communication device and may compute a response. In an instance in which the response to the challenge provided by the communication device matches the response (e.g., the response value) computed by the WiTT module **97** of the network device **605**, the WiTT module **97** may determine that the communication device **605** is registered to utilize the WiTT private key for communications with a detected wireless local network (e.g., Wi-Fi AP **32**, WLAN AP **30**, etc.). The WiTT module **97** may determine that the computed response matches the response received from the communication device, in an instance in which the WiTT module **97** runs the same hash function on the WiTT private key that is stored by the network device and calculates the same value as the response value determined by the WiTT manager **78** of the communication device **600**. On the other hand, in an instance in which the computed response does not match the response received from the communication device, the WiTT module **97** of the network device **605** may send an error message to the communication device. In this regard, the communication device **605** may need to communicate with the network device **605** again to obtain a temporary activation key and subsequently another WiTT private key per the approach of FIG. **6**. At operation **730**, the WiTT module **97** of the network device **605** may send a message (e.g., a SIP 200 OK message) to the communication device **600** confirming the successful registration indicating that the user is still authorized to utilize the previously received WiTT private key for WiTT service. As such, in response to receipt of the message indicating the successful registration, the communication device **600** may switch communications (e.g., a voice call and/or messaging (e.g., a SMS message, a MMS message and other data) from a cellular network to a detected wireless local network.

Referring now to FIG. **8**, a flowchart of an example method for authorizing a WiTT service is provided. At operation **800**, an apparatus (e.g., WiTT network device **605** (e.g., network device **108**)) may receive a request (e.g., a SIP NOTIFY message) to activate a service (e.g., a WiTT service) to enable transfer of communications provided by a cellular network device (e.g., cellular network entity **610** (e.g., network device **109**)) to a wireless local network (e.g., Wi-Fi AP **32**, WLAN AP **30**) in response to a communication device (e.g., communication device **600** (e.g., communication device **165**)) detecting the wireless local network. At operation **805**, an apparatus (e.g., WiTT network device **605**) may provide a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers (e.g., an MSISDN, an IMSI) of the request are valid.

At operation **805**, an apparatus (e.g., WiTT network device **605**) may provide a private key to the communication device to enable the communication device (e.g., communication device **600**) to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network (e.g., Wi-Fi AP **30**) or another wireless local network (e.g., Wi-Fi AP **36**). The apparatus may provide the private key to the communication device in response to receiving a message (e.g., a SIP NOTIFY message) for the private key from the communication device and receiving a cellular message (e.g., a cellular SMS message) from the cellular network device. The cellular message was initially received by the cellular network device (e.g., cellular network entity **610**) from the communication device (e.g., communication device **600**).

It should be pointed out that FIGS. **6**, **7** and **8** are flowcharts of a system, method and computer program product according to an example embodiment of the invention. It will be understood that each block of the flowcharts, and combinations of blocks in the flowcharts, can be implemented by various means, such as hardware, firmware, and/or a computer program product including one or more computer program instructions. For example, one or more of the procedures described above may be embodied by computer program instructions. In this regard, in an example embodiment, the computer program instructions which embody the procedures described above are stored by a memory device (e.g., volatile memory **422**, non-volatile memory **424**, memory **96**, memory **106**) and executed by a processor (e.g., processing device **408**, processor **94**, processor **104**, WiTT manager **78**, WiTT module **97**). As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (e.g., hardware) to produce a machine, such that the instructions which execute on the computer or other programmable apparatus cause the functions specified in the flowcharts blocks to be implemented. In one embodiment, the computer program instructions are stored in a computer-readable memory that can direct a computer or other programmable apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including instructions which implement the function(s) specified in the flowcharts blocks. The computer program instructions may also be loaded onto a computer or other programmable apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus implement the functions specified in the flowcharts blocks.

Accordingly, blocks of the flowcharts support combinations of means for performing the specified functions. It will also be understood that one or more blocks of the flowcharts, and combinations of blocks in the flowcharts, can be implemented by special purpose hardware-based computer systems which perform the specified functions, or combinations of special purpose hardware and computer instructions.

In an example embodiment, an apparatus for performing the methods of FIGS. **6**, **7** and **8** above may comprise a processor (e.g., the processing device **408**, the processor **94**, processor **104**, the WiTT manager **78**, the WiTT module **97**) configured to perform some or each of the operations (**1-13**, **700-730**, **800-810**) described above. The processor may, for example, be configured to perform the operations (**1-13**, **700-730**, **800-810**) by performing hardware implemented logical functions, executing stored instructions, or executing algorithms for performing each of the operations. Alternatively, the apparatus may comprise means for performing each of the operations described above. In this regard, according to an example embodiment, examples of means for performing operations (**1-13**, **700-730**, **800-810**) may comprise, for example, the processing device **408** (e.g., as means for performing any of the operations described above), the processor **94**, the processor **104**, the WiTT manager **78**, the WiTT module **97** and/or a device or circuitry for executing instructions or executing an algorithm for processing information as described above.

VII. Conclusion

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A method comprising:

receiving a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network;

enabling provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid;

enabling provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device, the cellular message was initially received by the cellular network device from the communication device; and utilizing the generated private key to subsequently register the communication device to transfer the other communications of the cellular network device to the wireless local network or the another wireless local network in response to receipt of another request from the communication device,

wherein utilizing the private key to register the communication device further comprises determining whether a value received from the communication device in response to a challenge matches a response value determined based in part on calculating a hash of the private key.

2. The method of claim **1**, wherein prior to enabling provision of the private key, the method further comprises validating an encrypted portion of the message based in part on using the temporary activation key and the one or more identifiers which are associated with the communication device.

3. The method of claim **2**, wherein the encrypted portion comprises a cryptographic hash of one of the identifiers and the temporary activation key, the cryptographic hash being generated by the cellular network device.

4. The method of claim **1**, wherein the cellular message comprises a cellular short message service message.

5. The method of claim **1**, wherein the message and the cellular message are received concurrently.

6. The method of claim **1**, wherein the one or more identifiers comprise at least one of a Mobile Station International Subscriber Directory Number or an International Mobile Subscriber Identity.

7. The method of claim **1**, wherein the wireless local network comprises at least one of a Wireless Fidelity access point or a Wireless Local Area Network access point.

8. The method of claim **1**, wherein enabling provision of the private key further comprises enabling provision of the private key in an encrypted message.

9. The method of claim **1**, wherein the communications comprise at least one of a voice call or a data message.

10. An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the processor, cause the apparatus to at least:

receive a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network;

enable provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid;

enable provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device, the cellular message was initially received by the cellular network device from the communication device;

utilize the generated private key to subsequently register the communication device to transfer the other communications of the cellular network device to the wireless local network or the another wireless local network in response to receipt of another request from the communication device; and

utilize the private key to register the communication device by determining whether a value received from the communication device in response to a challenge matches a response value determined based in part on calculating a hash of the private key.

11. The apparatus of claim **10**, wherein prior to enable provision of the private key, the memory and computer program code are further configured to, with the processor, cause the apparatus to:

validate an encrypted portion of the message based in part on using the temporary activation key and the one or more identifiers which are associated with the communication device.

12. The apparatus of claim **11**, wherein the encrypted portion comprises a cryptographic hash of one of the identifiers and the temporary activation key, the cryptographic hash being generated by the cellular network device.

13. The apparatus of claim **11**, wherein the cellular message comprises a cellular short message service message.

14. The apparatus of claim **10**, wherein the message and the cellular message are received concurrently.

15. The apparatus of claim **10**, wherein the one or more identifiers comprise at least one of a Mobile Station International Subscriber Directory Number or an International Mobile Subscriber Identity.

16. The apparatus of claim **10**, wherein the wireless local network comprises at least one of a Wireless Fidelity access point or a Wireless Local Area Network access point.

17. The apparatus of claim **10**, wherein the memory and computer program code are further configured to, with the processor, cause the apparatus to:

enable provision by enabling provision of the private key in an encrypted message.

18. The apparatus of claim **10**, wherein the communications comprise at least one of a voice call or a data message.

19. The apparatus of claim **10**, wherein the apparatus comprises a network device.

20. A computer program product comprising at least one non-transitory computer-readable storage medium having computer-readable program code portions stored therein, the computer-readable program code portions comprising:

program code instructions configured to cause receipt of a request to activate a service to enable transfer of communications provided by a cellular network device to a wireless local network in response to a communication device detecting the wireless local network;

program code instructions configured to enable provision of a temporary activation key to the communication device in response to receiving an indication from a cellular network device denoting that the communication device is authorized to utilize the service based in part on determining that one or more identifiers of the request are valid;

program code instructions configured to enable provision of a private key to the communication device, to enable the communication device to utilize the private key to subsequently register to transfer other communications of the cellular network device to the wireless local network or another wireless local network, in response to receiving a message for the private key from the communication device and receiving a cellular message from the cellular network device, the cellular message was initially received by the cellular network device from the communication device;

program code instructions configured to utilize the generated private key to subsequently register the communication device to transfer the other communications of the cellular network device to the wireless local network or the another wireless local network in response to receipt of another request from the communication device; and

program code instructions configured to utilize the private key to register the communication device by determining whether a value received from the communication device in response to a challenge matches a response value determined based in part on calculating a hash of the private key.

21. The computer program product of claim **20**, wherein prior to enable provision of the private key, the computer program product further comprises:

program code instructions configured to validate an encrypted portion of the message based in part on using the temporary activation key and the one or more identifiers which are associated with the communication device.

* * * * *